

R E P O R T R E S U M E S

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MACHINE TOOL OPERATOR--GENERAL, ENTRY, SUGGESTED GUIDE FOR A TRAINING COURSE.

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DESCRIPTORS- *CURRICULUM GUIDES, POST SECONDARY EDUCATION, *TRADE AND INDUSTRIAL EDUCATION, *MACHINE TOOL OPERATORS, ADULT VOCATIONAL EDUCATION, MDTA PROGRAMS,

THE PURPOSE OF THIS CURRICULUM GUIDE IS TO ASSIST THE ADMINISTRATOR AND INSTRUCTOR IN PLANNING AND DEVELOPING MANPOWER DEVELOPMENT AND TRAINING PROGRAMS TO PREPARE MACHINE TOOL OPERATORS FOR ENTRY-LEVEL POSITIONS. THE COURSE OUTLINE PROVIDES UNITS IN -- (1) ORIENTATION, (2) BENCH WORK, (3) SHOP MATHEMATICS, (4) BLUEPRINT READING AND SKETCHING, (5) POWER SAWS, (6) DRILL PRESS, (7) ENGINE LATHE, (8) MILLING MACHINE, (9) SURFACE AND CYLINDRICAL GRINDERS, (10) SHAPER, AND (11) MASS PRODUCTION METHODS. EACH UNIT CONTAINS A TIME ALLOCATION, OBJECTIVES, UNIT OUTLINE, SUGGESTED ACTIVITIES, AND A LIST OF REFERENCES. INSTRUCTION IN RELATED THEORY IS TO BE CONCURRENT WITH THE DEVELOPMENT OF SKILLS IN THE SHOP. SUGGESTIONS FOR PLANNING THE LESSONS AND EVALUATING THE STUDENTS ARE INCLUDED. THE TRAINING SCHEDULE IS DEVELOPED FOR 1,080 HOURS OF TRAINING IN A PERIOD OF 27 WEEKS. THE INSTRUCTOR SHOULD HAVE BROAD EXPERIENCE AS A SKILLED MACHINE TOOL OPERATOR AND, PREFERABLY, EXPERIENCE AS A SUPERVISOR OF MACHINE TOOL OPERATORS. THE TRAINEE SHOULD HAVE A HIGH SCHOOL EDUCATION OR EQUIVALENT WITH A BACKGROUND IN MATHEMATICS AND SHOULD BE OF AVERAGE PHYSICAL CONDITION AND HEALTH WITH GOOD VISION. SUPPLEMENTARY MATERIALS INCLUDE A LAYOUT OF A TRAINING FACILITY AND SUGGESTED MACHINES. TOOLS, EQUIPMENT, AND EXPENDABLE SUPPLIES FOR A CLASS OF 20 PERSONS. SUGGESTED TEXTBOOKS, REFERENCES, AND FILMS ARE LISTED. (HC)

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**A Suggested Guide
for a Training
Course**

MACHINE TOOL OPERATOR

General, Entry

***U.S. Department of Health, Education, and Welfare
Office of Education***

VT 02411

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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M A C H I N E T O O L O P E R A T O R

General, Entry

(D.O.T. Occupational Code 6-78.905)

Suggested Guide for a Training Course

U. S. Department of Health, Education, and Welfare
John W. Gardner, Secretary

Office of Education
Francis Keppel, Commissioner

Manpower Development and Training Program

CONTENTS

	Page
FOREWORD.....	iii
TRAINING COURSE FOR MACHINE TOOL OPERATOR--GENERAL, ENTRY	
Purpose of the Guide.....	1
Job Description.....	1
Qualifications of Trainees.....	2
Teacher Qualifications.....	2
Suggestions for the Organization of Instruction.....	2
Length of Course and Course Units.....	3
COURSE UNITS	
I. Orientation.....	5
II. Bench Work.....	6
III. Shop Mathematics.....	7
IV. Blueprint Reading and Sketching.....	8
V. Power Saws.....	9
VI. Drill Press.....	10
VII. Engine Lathe.....	11
VIII. Milling Machine.....	12
IX. Surface and Cylindrical Grinders.....	13
X. Shaper.....	14
XI. Mass Production Methods.....	15
TEACHING THE COURSE	
Planning the Lesson.....	17
Training Facility Considerations.....	17
Criteria for Evaluating Trainee Readiness for Employment.....	18
SUGGESTED LIST OF TEXTBOOKS AND REFERENCES.....	19
SUGGESTED LIST OF FILMS.....	22
APPENDIXES	
A. Suggested List of Machines.....	25
B. Suggested List of Tools.....	26
C. Suggested List of Equipment.....	27
D. Suggested List of Expendable Supplies.....	28
E. Suggested Training Facilities.....	30

FOREWORD

Throughout American industry almost every product contains metal parts or is processed by machines made of metal. Many of these metal parts are made by machine operators. The largest group of workers in the metal-working trades is made up of machine operators and totals 570,000 persons.

Employment of machine tool operators is expected to rise moderately during the remainder of the 1960's and beyond. Most job opportunities, however, will arise from the need to replace experienced workers who transfer to other jobs, retire or die. Retirements and death (alone) may result in about 12,000 job openings each year.

Technological developments will affect both the number and skill requirements of machine tool operators. The continued development and use of faster and more versatile automatic machine tools will result in greater output per operator. Workers with thorough backgrounds in machine operations, mathematics, blueprint reading, and a good working knowledge of the properties of metals will be better able to adjust to future technological changes and to transfer to new jobs in the machining field.

The purpose of this guide is to assist administrators and teachers in organizing courses and developing course content for programs designed to prepare persons for employment in this occupation.

The guide was prepared for the Division of Vocational and Technical Education under contractual arrangements with Oklahoma State University. Recognition is given to Maurice W. Roney, Professor of Industrial Education, Oklahoma State University, for supervising the guide; to L. Carl Love, Oregon State University, for his assistance as consultant; and to Ollie B. Stone, Machine Shop Instructor, Oklahoma City Public Schools, for gathering the technical content.

This guide contains eleven major units covering 1080 hours of instruction in the classroom and shop. The sequence of instructional units and the hours assigned to each unit are flexible; therefore, both time and content may be adjusted to better meet local needs.

A suggested list of machines, tools, equipment, textbooks, films, and a floor plan of the training facility have been included to assist administrators and teachers in organizing the course. The assistance of local advisory groups should be sought for guidance in selecting equipment and developing content of courses which will best serve the local conditions.

Walter M. Arnold
Assistant Commissioner
for Vocational and
Technical Education

TRAINING COURSE FOR MACHINE TOOL OPERATOR--GENERAL, ENTRY

Purpose of the Guide

This guide has been prepared to assist in planning and developing a training course for machine tool operators. It has been organized in a manner to be of maximum value to school administration personnel who are not themselves specialists in the occupation. Sufficient detail has been included, however, to provide a basic outline of instruction to assist the instructor who will be responsible for the operation of the training program.

The suggestions outlined in the training guide are not intended to delineate instruction in every detail. Supplemental material can be found in the suggested textbooks, references, and films. In addition, the suggested course outline may require modification to meet special needs. The sequence of presentation, as well as the final selection of topics for special emphasis, should be determined by instructional specialists, and may vary according to the needs and background of the trainee group.

Although this training guide has been developed primarily for use in the Manpower Development and Training program, it includes instructional material that goes beyond the development of manipulative exercises to impart simple skills. Some of the related material included in the course outline has been added to assist the trainee to progress beyond the entry level job.

Job Description

Machine tool operators shape metal to precise dimensions by the use of machine tools. Although some operators can operate several tools, most can operate only one or two machine tools. Many operators are essentially machine tenders who perform simple, repetitive operations which can be learned quickly. Other machine tool operators, however, are much more skilled and can perform complex and varied machining operations.

Lathes, drill presses, boring machines, grinding machines, milling machines, and automatic screw machines are among the machine tools used by machine operators. Both skilled and semiskilled operators have job titles based upon the kind of machine they operate, such as engine lathe operator, milling machine operator, and drill press operator.

A typical job of the semiskilled operator is to place rough metal stock in a machine tool on which the speeds, feeds, and operation sequence have already been set by a skilled worker. The operator watches the machine and calls his supervisor when anything unusual happens. Special, easy-to-use gages help him to measure work quickly and accurately. The operator with limited training may make minor adjustments to keep his machine tool operating, but he depends on skilled machining workers for major adjustments. The majority of machine tool operators fit this category and are less skilled than the skilled operators described in the following paragraph.

The work of skilled machine tool operators is similar to that of all-round machinists, except that often it is limited to a single type of machine and involves little or no hand fitting or assembly work. (By contrast, all-round machinists can operate almost every machine tool.) The skilled machine tool operator plans and sets up the correct sequence of machining operations in accordance with blueprints, layouts, or other instructions. He adjusts speed, feed, and other controls and selects the proper cutting tools for each operation. Adjustments may be necessary during machine operations, and changes in setup also may be required. Therefore, the skilled operator must be able to use all the special attachments of his machine. Upon completing his work, he checks measurements with micrometers, gages, and other precision-measuring instruments to see whether they meet specifications. The skilled machine tool operator also may select cutting and lubricating oils used to cool metal and tools during machining operations.

The work of the machine tool operator requires knowledge and skill in the use of several different machines for the production of devices which may consist of a variety of metals. The skilled machine tool operator produces parts and assemblies that conform to certain specified tolerances; at the same time, he must meet certain requirements for quantity output.

Qualifications of Trainees

High school graduation, or its equivalent, is desirable for those who plan to enter the machine tool operator trade. Machining operations require planning with the aid of mathematics; some mathematical computations involving trigonometry will be encountered and trainees should have a background of mathematics. The trainee should be of average physical condition and health; good vision is especially important and should be at least correctable to 20/20.

The United States Employment Service General Aptitude Test Battery B-397 for machine operator, general, would be helpful in the selection of trainees.

Teacher Qualifications

A teacher for this program must have broad experience as a skilled machine tool operator and, preferably, should have experience as a supervisor of machine tool operators.

If the person selected for this teaching assignment does not have teaching experience, he should be given the necessary teacher education fundamentals such as: lesson planning, teaching methods, and course construction.

Suggestions for the Organization of Instruction

The field of machine tool operation has changed quite rapidly during the last few years. A recent publication by the American Society of Tool and Manufacturing Engineers carried a statement that our metal cutting capacity has been doubled every ten years since 1930. Because of the vast changes being made in machine processes, it is suggested that trainees be given an overview of industry in addition to a sound foundation in the fundamentals of basic operations.

In accordance with the job description, it is suggested that the trainees develop skills on one or more of the machine tools included in the course. In other situations the training may include all of the content covered in this guide thereby meeting the specific needs of industries in the community who require their operators to have a degree of skill on all machines. The instructor should be aware of the course organizational and operational problems which will arise if either one or a combination of these plans are followed. Whatever plan is finalized will affect the number of specific machines and supplies needed, and the scheduling of both shop and related instruction in order to conduct an effective course.

As indicated in the course outline, emphasis on theory, related shop mathematics, and sketching and blueprint reading reflects the need to provide the trainee with as much related theory as possible. It is because of this understanding of "why" that he can transfer from job to job and remain employable. While related theory is important, it is expected that the instructor will maintain a direct correlation between theory and actual shop practice. Assignments in mathematics, sketching, and related theory should be carried on concurrently with the development of skills in the shop.

The allocation of hours to each unit of instruction serves to indicate the relative emphasis to be placed on these units. Changes in this distribution of time may be necessary, depending on the ability and background of the trainees and the needs of industry. The administrator or instructor must keep in mind that this training course is designed for job entry.

At some appropriate point in the training program field trips to local industries will be helpful. Special equipment and processes such as: electrical discharge machining, free abrasive grinding, or numerical control, can best be introduced by visits to industry. Additional information covering modern methods of machining and related material will be found in the suggested list of textbooks and references.

Length of Course and Course Units

The training program, as outlined, covers a period of 27 weeks with a total of 1080 hours of class instruction and laboratory practice. The training is programmed for 6 hours per day and 5 days per week.

<u>Unit</u>	<u>Title</u>	<u>Suggested class hours</u>	<u>Suggested shop hours</u>
I.	Orientation	6	6
II.	Bench Work	10	30
III.	Shop Mathematics	50	0
IV.	Blueprint Reading and Sketching	40	0
V.	Power Saws	5	10
VI.	Drill Press	10	33
VII.	Engine Lathe	60	300
VIII.	Milling Machine	40	150
IX.	Surface and Cylindrical Grinders	25	100
X.	Shaper	15	70
XI.	Mass Production Methods	20	100
Sub-total		281	799
			281
Total			1080

Course Unit I

ORIENTATION

Training Time

Classroom, 6 hours; shop, 6 hours

Objectives

To orient trainees to the nature and scope of the training course and the machine tool operator's work.

To develop an understanding and appreciation of shop safety.

Unit Outline

- A. Departmental policies
- B. Overview of course
- C. Safety policies in the shop

Suggested Activities

1. Tour of shop facilities
2. Personal safety practices
3. Safety practices in using equipment, machines, and tools
4. Civil Defense procedures, fires, etc.

References

Accident Prevention Manual for Shop Teachers. American Technical Society.
Hall, Herbert D. and Horace E. Linsley. Machine Tools, What They Are and How They Work; An Introduction to the Fundamentals of Mass Production--The Tools, Machines, Gages, and Methods That Make Up Our Modern Metal Working Industries and Automated Production Lines.
Shop Safety Education. The University of The State of New York.

Course Unit II

BENCH WORK

Training Time

Classroom, 10 hours; shop, 30 hours

Objectives

To develop knowledge and skills in the identification, use, care, maintenance and safety of hand tools, and to develop knowledge and skills in layout.

Unit Outline

- A. Identification, use, care, and maintenance of hand tools
- B. Laying out work
 - 1. Tools
 - 2. Measurements
 - 3. Procedures
- C. Hand-threading
 - 1. Taps
 - 2. Dies
- D. Filing and burring
- E. Holding devices
- F. Assembly procedures
- G. Safety

Suggested Activities

- 1. Hand hacksawing
- 2. Filing
- 3. Hand drilling, portable electric
- 4. Chipping and shearing with cold chisel
- 5. Hand-threading, taps and dies
- 6. Finishing with file and emery cloth

References

Morgan, Alfred P. How to Use Tools.
Machine Trades I, Learner's Manual. Instructional Materials Laboratory, Ohio
State University.

Course Unit III

SHOP MATHEMATICS

Training Time

Classroom, 50 hours

Objectives

To provide the necessary knowledge and skills in shop mathematics relating to machine operations.

Unit Outline

- A. Arithmetic
 - 1. Definition of terms
 - 2. Fractions and decimals
 - 3. Ratio and proportion
 - 4. Areas and volumes
 - 5. Measurements and conversion factors
- B. Algebra
 - 1. Equations
 - 2. Shop formulas
- C. Geometry
 - 1. Geometrical constructions
 - 2. Areas and volumes
- D. Trigonometry
 - 1. Sines and co-sines
 - 2. Tangents and cotangents

Suggested Activities

- 1. Using measuring devices and calculations needed for precision measurement
- 2. Solving problems in measuring stock for layout
- 3. Using formulas for cutting speeds and feeds
- 4. Figuring angles
- 5. Solving problems in indexing
- 6. Solving problems on screw threads and tapers

References

Felker, C. A. Shop Mathematics.

Graham, Frank Duncan. Audel's Mathematics and Calculations for Mechanics, A Ready Reference.

McMackin, Frank J. and John H. Shaver. The Mathematics of the Shops.

Course Unit IV

BLUEPRINT READING AND SKETCHING

Training Time

Classroom, 40 hours

Objectives

To develop knowledge and skills in blueprint reading and freehand sketching.

Unit Outline

- A. Graphic language
- B. Working drawings
- C. Selection of views
- D. Orthographic drawings
- E. Dimensioning
- F. Isometric drawings
- G. Auxilliary views
- H. Sectional views
- I. Tolerances
- K. Sketching

Suggested Activities

- 1. Freehand sketching practice
- 2. Blueprint reading practice
- 3. Laying out jobs from blueprints

References

Elementary Blue Print Reading for Beginners in Machine Shop Practice. Delmar
Publishers, Inc.

Course Unit V

POWER SAWS

Training Time

Classroom, 5 hours; shop, 10 hours

Objectives

To develop knowledge and skills in the operation, maintenance, and safety of power saws.

Unit Outline

- A. Layout for cutting operations
- B. Band saw
 - 1. Types of blades
 - 2. Welding blades
 - 3. Straight sawing
 - 4. Contour sawing
 - 5. Speeds
- C. Power hacksaw
 - 1. Types of blades
 - 2. Holding the work
- D. Coolants
- E. Safety and maintenance

Suggested Activities

- 1. Sawing to length
- 2. Angular sawing
- 3. Contour sawing
- 4. Removing and installing blade

References

Apprentice Training Handbook. National Tool, Die, and Precision Machining Assn.
Burghardt, Henry D. and Aaron Axelrod. Machine Tool Operation, Part II.
Habicht, Frank H. Modern Machine Tools.
Krar, S. F. and J. E. St. Almand. Machine Shop Training.

Course Unit VI

DRILL PRESS

Training Time

Classroom, 10 hours; shop, 33 hours

Objectives

To develop knowledge and skills in the operation, maintenance, and safe use of the drill press.

Unit Outline

- A. Types of drilling machines
 - 1. Drill press
 - 2. Sensitive drill press
 - 3. Radial drill press
 - 4. Jig borer
- B. Work holding devices
 - 1. Drill vise
 - 2. V-Blocks
 - 3. Angle plates
 - 4. Jigs and fixtures
- C. Feeds and speeds
- D. Types of drills
 - 1. Sizes
 - 2. Sharpening
- E. Drilling operations
- F. Reaming operations
- G. Counterboring and countersinking operations
- H. Tapping operations
- I. Care, maintenance, and safety

Suggested Activities

- 1. Mounting tools
- 2. Drilling
- 3. Reaming
- 4. Tapping
- 5. Using jigs and fixtures
- 6. Counterboring and countersinking
- 7. Grinding drills
- 8. Holding work

References

Habicht, Frank H. Modern Machine Tools.
Increased Production, Reduced Costs Through a Better Understanding of the Machining Process and Control of Materials, Tools, and Machines. Curtiss-Wright Corp.

Course Unit VII

ENGINE LATHE

Training Time

Classroom, 60 hours; shop, 300 hours

Objectives

To provide knowledge and skills in the operation, maintenance, and safe use of the engine lathe.

Unit Outline

- A. Types and sizes
- B. Tool holders and tool bits
 - 1. Sharpening tool bits
- C. Speeds and feeds
- D. Mounting work
 - 1. Between centers
 - 2. Chucking
- E. Types of operations
 - 1. Turning
 - 2. Facing
 - 3. Shouldering
 - 4. Chamfering
 - 5. Knurling
 - 6. Taper turning
 - 7. Thread cutting (external and internal)
 - 8. Drilling and reaming
 - 9. Boring
 - a. Straight and shoulder
 - b. Tapers
 - 10. Undercutting and necking
 - 11. Cutting off
 - 12. Tapping
- F. Planning job and sequence of operations
- G. Safety and maintenance

Suggested Activities

Performing repetitive operations listed in E above on practical jobs.

References

- DeGroat, George H. Metal Working Automation.
Hallett, F. H. Machine Shop Theory and Practice
How to Run a Lathe. South Bend Lathe Works.
Smith, Robert E. Machining of Metal.

Course Unit VIII

MILLING MACHINE

Training Time

Classroom, 25 hours; shop, 150 hours

Objective

To develop knowledge and skills in the operation, maintenance, and safe use of the milling machine.

Unit Outline

- A. Types and sizes
- B. Types of cutters
- C. Work holding devices and clamping methods
 - 1. Milling machine vise
 - 2. Angle plates
 - 3. Clamps
- D. Feeds and speeds
- E. Installing arbors and cutters
- F. Milling operations
 - 1. Plain milling
 - 2. Face milling
 - 3. Straddle milling
 - 4. Slotting
 - 5. End milling
 - 6. Gang milling
 - 7. Helical milling
 - 8. Gear cutting
- G. Indexing methods
- H. Coolants
- I. Care, maintenance, and safety

Suggested Activities

Performing the various milling operations listed in F above on practical jobs.

References

- Burghardt, Henry D. and Aaron Axelrod. Machine Tool Operation, Part II.
DeGroat, George H. Metal Working Automation.
Smith, Robert E. Machining of Metal.

Course Unit IX

SURFACE AND CYLINDRICAL GRINDERS

Training Time

Classroom, 25 hours; shop, 100 hours

Objectives

To develop knowledge and skills in the operation, maintenance, and safe use of surface cylindrical grinders.

Unit Outline

- A. Grinding wheels
 - 1. Types and sizes
 - 2. Grades
 - 3. Wheel selection
- B. Surface grinders
 - 1. Types
 - 2. Work holding devices
 - a. Magnetic chuck
 - b. Vise
 - 3. Mounting and dressing wheel
 - 4. Surface grinding operations
 - a. Grinding flat surfaces
 - b. Squaring stock
 - c. Grinding angles
 - 5. Care, maintenance, and safety
- C. Cylindrical grinders
 - 1. Types and accessories
 - 2. Mounting and dressing wheel
 - 3. Holding the work
 - 4. Cylindrical grinding operations
 - a. Straight grinding
 - b. Grinding to a shoulder
 - c. Taper grinding
 - 5. Care, maintenance, and safety

Suggested Activities

Performing the various grinding operations listed above in B.4 and C.4 on practical jobs.

References

- Burghardt, Henry D. and Aaron Axelrod. Machine Tool Operation, Part II.
Habicht, Frank H. Modern Machine Tools.
Smith, Robert E. Machining of Metal.

Course Unit X

SHAPER

Training Time

Classroom, 15 hours; shop, 70 hours

Objectives

To develop knowledge and skills in the operation, maintenance, and safe use of the shaper.

Unit Outline

- A. Types and sizes
- B. Feeds and speeds
- C. Work holding devices
 - 1. Vise
 - 2. Parallels
 - 3. Clamps
- D. Cutting tools
 - 1. Types and shapes
 - 2. Sharpening tools
- E. Shaper operations
 - 1. Horizontal shaping
 - 2. Angular shaping
 - 3. Vertical shaping
 - 4. Contour shaping
 - 5. Keyway and slot shaping
- F. Care, maintenance, and safety

Suggested Activities

Performing repetitive shaper operations listed above in E on practical jobs.

References

Habicht, Frank H. Modern Machine Tools.
Shop Theory. McGraw-Hill Book Co., Inc.
Smith, Robert E. Machining of Metal.

Course Unit XI

MASS PRODUCTION METHODS

Training Time

Classroom, 20 hours; shop, 100 hours

Objectives

To develop an understanding of mass production methods and knowledge and skills in the operation of certain specialized mass production machines.

Unit Outline

- A. Turret lathes
 - 1. Application to mass production
 - 2. Types and sizes
 - 3. Feeds and speeds
 - 4. Methods of holding work
 - a. Chucks
 - b. Collets
 - c. Special fixtures
 - 5. Tooling of turret
 - a. Number and kinds of operations
 - b. Progressive sequence of operations
 - c. Tooling for maximum efficiency
 - d. Types of cutting tools
 - 6. Coolants
 - 7. Turret lathe operations
 - 8. Care, maintenance, and safety
- B. Screw machines
 - 1. Application to mass production
 - 2. Types and sizes
 - 3. Methods of holding work
 - 4. Screw machine tooling
 - a. Number and kinds of operations
 - b. Sequence of operations
 - c. Actuating and controlling tools
 - 5. Speeds and feeds
 - 6. Cutting fluids
 - 7. Screw machine operations
 - 8. Care, maintenance, and safety

Suggested Activities

Performing the variety of turret lathe and screw machine operations on practical jobs.

References

Automatic Machining, (magazine). Screw Machine Publishing Co.

Bower, C. T. Aids to Machine Shop Practice.

DeGroat, George H. Metal Working Automation.

Increased Production, Reduced Costs Through a Better Understanding of the Machining Process and Control of Materials, Tools, and Machines. Curtiss-Wright Corp.

TEACHING THE COURSE

Planning the Lesson

The best guide or lesson plan is, of course, one that has been prepared by the individual teacher, based on personal experience and manner of teaching. Although teachers differ in their ways of organizing and coordinating important parts of their presentation, they agree that the purpose of a lesson is effective and meaningful classroom instruction.

Written plans may be brief, but the good teacher will know before the class starts:

1. The goals or objectives of the lesson--the kind of learning desired
2. The outline and suggested time schedule for the lesson, including:
 - a. An interest approach--a way to introduce the lesson, to capture the interest of the trainees and to direct their attention to the lesson's goals or objectives
 - b. Activities which will involve the trainees in discovering new facts and principles, solving realistic problems, or practicing skills
 - c. A way to summarize the lesson--to help trainees arrive at some valid conclusions and/or to evaluate the extent to which lesson goals have been achieved
3. The subject matter content--the facts and principles or main ideas to be brought out in the lesson
4. The teaching materials and references to be used

Training Facility Considerations

The items of machines, tools, equipment and supplies included as appendixes in this guide indicate what is needed to prepare a group of twenty trainees to enter the machine tool operator occupation. The items listed represent an optimum program, however, the instructor responsible for a particular program may wish to make some substitutions, deletions, and additions to the lists shown depending on the particular industrial needs of the community. If the course is to be offered in an existing facility, the administrator should make a careful inventory of existing equipment in order to avoid costly duplications.

The laboratory floor plan indicates a typical arrangement that might be used in industry to give the greatest production schedule with the lowest overhead cost. The arrangement is planned for maximum safety. It is suggested that the safety lane be a full 36 inches wide, and that no machinery be located within one foot of this area. To make the safety lane especially effective, green anti-slip paint should be used with yellow 4-inch borders, also of anti-slip material. The use of a standard industrial color scheme on every machine throughout the working area is also recommended as a safety measure.

Prices shown on listed items are for the purpose of indicating the approximate quality of each item. No attempt has been made to list the complete specifications needed by a supplier for the purpose of completing a purchase order.

Criteria for Judging Trainee Readiness for Employment

The criteria which serve as guides for determining whether the trainee is ready for employment as a machine tool operator may be more stringent than in some other occupations. However, some understanding and insight into how to provide various services are of such importance that every attempt should be made to evaluate trainee progress.

The use of various evaluative devices is necessary for the teacher and the trainee to accumulate objective information about the growth of the trainee. The following kinds of competencies are important to develop or to strengthen during the training program.

A. Personal qualities:

1. Courtesy, friendliness, and tact in dealing with supervisors, and the general public
2. Acceptable appearance--good grooming
3. Mature judgment in a variety of typical situations
4. Good personal habits in speech, mannerisms, cleanliness, and methods of work
5. Acceptable attitudes--calmness in disorganized situations, positive attitude toward work, cooperativeness, willingness to work with others
6. Assumption of role appropriate for the machine tool operator

B. Activities showing knowledge, understanding, and skills:

1. Understands and carries out instructions or directions
2. Works effectively under supervision
3. Demonstrates knowledge of basic machine operation techniques
4. Understands need for safety--dangerous areas, basic precautions
5. Uses common machine tools and equipment carefully
6. Demonstrates ability to develop and follow a work plan or schedule

SUGGESTED LIST OF TEXTBOOKS AND REFERENCES

- X Accident Prevention Manual for Shop Teachers. Edited by William A. Williams, American Technical Society, Chicago, Ill.: 1963.
- American Machinist, (magazine) Paul F. Cowie, Publisher, 330 West 42nd Street, New York: 10036.
- Apprentice Training Handbook. Published by National Tool, Die, and Precision Machining Assn., 1411 K Street, Northwest, Washington, D. C., 1964.
- Automatic Machining, (magazine) Howard Spaulding, Publisher, Screw Machine Publishing Co., 65 Broad Street, Rochester, N. Y., 14614.
- Bower, C. T. Aids to Machine Shop Practice. New York: MacMillan, 1961.
- Burghardt, Henry D. and Aaron Axelrod. Machine Tool Operation, Part I. New York: McGraw-Hill Book Co., Inc., 1959.
- Burghardt, Henry D. and Aaron Axelrod. Machine Tool Operation, Part II. New York: McGraw-Hill Book Co., Inc., 1959.
- DeGroat, George H. Metal Working Automation. New York: McGraw-Hill Book Co., Inc., 1962.
- Elementary Blue Print Reading for Beginners in Machine Shop Practice. Albany, N. Y.: Delmar Publishers, Inc., 1946.
- Felker, C. A. Machine Shop Technology. Milwaukee, Wis.: Bruce Publishing Co., 1962.
- Felker, C. A. Shop Mathematics. Milwaukee, Wis.: Bruce Publishing Co., 1959.
- Fundamentals of Tool Design: Concerning The Theory, Principles and Techniques for the Modern Design of Cutting Tools, Cutting and Forming Dies, Fixtures, and Other Related Tooling. American Society of Tool and Manufacturing Engineers, Englewood Cliffs, N. J.: Prentice Hall, 1962.
- Graham, Frank Duncan. Audel's Mathematics and Calculations for Mechanics, A Ready Reference. New York: T. Audel & Co., 1959.
- Graham, Frank Duncan. Audel's Machinists' and Toolmakers' Handbook. New York: T. Audel & Co., 1961.
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- Machine and Tool Blue Book, (magazine) William F. Schleicher, Publisher, Hitchcock Publishing Co., Hitchcock Building, Wheaton, Ill.
- Machinery, (magazine) Charles O. Herb, editor, Industrial Press, 93 Worth Street, New York, 10013.
- Machine Trades I Learners Manual. Trade and Industrial Education, Instructional Materials Laboratory, Ohio State University, College of Education, Columbus 10, Ohio.
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- Machining With Carbides and Oxides. New York: American Society of Tool Manufacturing Engineers, New York: McGraw-Hill, 1962.
- Mathematics--Machine Shop Series. Delmar Publishers, Inc., Albany, N. Y., 1946.
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- Metal Working, (magazine) Cahners Publishing Co., Inc., 221 Columbus Avenue, Boston 16, Mass.
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- Numerical Control in Manufacturing. New York: McGraw-Hill Book Co., Inc., 1963.
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- Palmer, Frank R. and George V. Luerksen. A Handbook of Modern Practice For The Man Who Makes Tools, 2nd Ed. Reading, Pa.: Carpenter Steel Co., 1948.
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Tool and Manufacturing Engineer, (magazine) Harry E. Conrad, publisher. The American Society of Tool and Manufacturing Engineer's, 5400 W. Good Hope Road, Milwaukee, Wis.

Tooling & Production, (magazine) Ray L. Heubner, publisher. Huebner Publications, Inc., 13601 Euclid Avenue, Cleveland, Ohio.

SUGGESTED LIST OF FILMS

TEAM WORK--THE TOOL STEEL STORY

16 mm, sound, color, 30 minutes
Modern Talking Picture Service, Inc.
3 East 54th Street
New York, N. Y., 1956

ALUMINUM ON THE MARCH

16 mm, sound, color, 28 minutes
Associated Films, Inc
347 Madison Avenue
New York 17, N. Y., 1956

OPTICAL TOOLING

16 mm, sound, color, 35 minutes
Sales Planning Department
Charles Bruning Co.
4700 Montrose Avenue
Chicago, Ill.

THE FORD PEOPLE

16 mm, sound, color, 22 minutes
Ford Film Libraries
16 East 52nd Street
New York 22, N. Y.

ABC OF HAND TOOLS, Part 1 and 2

16 mm, sound, color, 33 minutes
General Motors Corporation
405 Montgomery Street
San Francisco 4, Calif.

THE ART OF REAMING

16 mm, sound, 47 minutes
The Cleveland Twist Drill Company
1242 East 49th Street
Cleveland 14, Ohio

BEING ON TIME

16 mm, sound
Audio-Visual Center
Brigham Young University
Provo, Utah

CHISELS & HAMMERS

16 mm, sound, 23 minutes
Cromers' Modern Films
28 East 9th Avenue
Denver 3, Colo.

COOL CHIPS

16 mm, sound, 13 minutes

The Cincinnati Milling Machine Company

Cincinnati Milling Products Division

Advertising Department

4701 Marburg Avenue

Cincinnati 9, Ohio

DON'T DROP YOUR GUARD

16 mm, sound, color, 10 minutes

Aetna Life Affiliated Companies

Public Education Department

151 Farmington Avenue

Hartford 16, Conn.

ELEMENTARY OPERATIONS ON THE ENGINE LATHE

16 mm, sound

Iowa State College

Department of Public Instruction

Division of Vocational Education

Ames, Iowa

GRINDING CUTTER BIRS

16 mm, sound, color, 20 minutes

425 East Madison Street

South Bend 22, Ind.

THE GRINDING WHEEL, ITS CARE AND USE

16 mm, sound, color, 17 minutes

Norton Company

Publicity Department

Worcester 6, Mass.

HIGHWAY TO PRODUCTION

16 mm, sound, 30 minutes

The Cincinnati Milling Machine Co.

Cincinnati Milling Products Division

Advertising Department

4701 Marburg Avenue

Cincinnati 9, Ohio

NUMERICAL CONTROL

16 mm, sound, color, 30 minutes

(Application of numerical control to turret drilling, tapping, boring and milling. Also advantages such as reduced lead time, precise machining, exact repetition, reduced tooling costs, etc.)

Burgmaster Corp.

15001 South Figueroa Street

Gardena, Calif.

GRINDING WHEEL SAFETY

16 mm, sound, color, 20 minutes

Norton Company

Publicity Department

Worcester 6, Massachusetts

PRECISION TOOL MAKING AND MACHINING--KEYSTONE OF AMERICAN INDUSTRY

16 mm, sound, 30 minutes

Examines Role of: Tool, Die, and precision machining industry in mass production and shows how apprentices are trained.

National Tool, Die and Precision Machining Assn.

907 Public Square Building

Cleveland, Ohio 44113

KEY TO THREADING ECONOMY

16 mm, sound, color, 20 minutes

Advertising Department

Landis Machine Co.

Waynesboro, Pennsylvania

COMMAND PERFORMANCE

16 mm, sound, color, 13 minutes

Traces in Detail: Six basic cycles of a numerically controlled turret drill

Cincinnati Lathe and Tool Co.

Attention: John Mitchell, Sales Manager

Cincinnati 9, Ohio

APPENDIX A. SUGGESTED LIST OF MACHINES

<u>Quantity</u>	<u>Description</u>	<u>Estimated total cost</u>
3	Sensitive drill presses, floor model, size 15"	\$ 840.00
1	Upright drill press	350.00
1	Radial drill press, 3 ft. arm	500.00
2	Grinders, bench or pedestal, 6-8" wheel dual arbor	300.00
1	Grinder, pedestal, 10-14" wheel, dual arbor	308.00
1	Disc sander, 15"	150.00
1	Belt sander, 4" x 60"	400.00
1	Upright metal cutting band saw	980.00
1	Power hacksaw	450.00
1	Tool grinder, with attachments	952.00
1	Surface grinder	1995.00
1	Cylindrical grinder - distance between centers 22", swing over table 8½", table travel 14".	2000.00
5	Engine lathes with motor, complete tooling 10" x 3'	6500.00
5	Engine lathes with motor, complete tooling 13" x 5'	9500.00
1	Engine lathe with motor, complete tooling 30" x 8'	2400.00
1	Milling machine, universal	4000.00
1	Milling machine, vertical	4000.00
1	Shaper, 20"	3000.00
1	Shaper, 30"	4000.00
1	Turret lathe with tooling, No. 3	6000.00
1	Jig boring machine for drilling, reaming and precision boring	1495.00
1	Screw machine, 10-inch swing, 40" bed, collet capacity -- 1"	1490.00
2	Hardness testing machines, complete with accessories for testing hard and soft materials	1300.00
1	Arbor press, hydraulic, 25 ton capacity	325.00

APPENDIX B. SUGGESTED LIST OF TOOLS

<u>Quantity</u>	<u>Description</u>	<u>Estimated total cost</u>
20 sets	Hand tools (hammers, punches, chisels, scales, try-squares, pliers, wrenches, screwdrivers, files, hacksaw, 20-drawer roller cabinet, etc.)	\$1980.00
20	Small micrometers, 0-1", 1-2", 2-3", and 3-4"	500.00
3	Dial-test indicators, complete, assorted fixed gages	75.00
1	Electric drill, portable, $\frac{1}{4}$ " capacity	45.00
1	Electric drill, portable, $\frac{1}{2}$ " capacity	70.00
3	Drill set, fractional, $\frac{1}{64}$ " to 2"	600.00
3	Drill set, numbered, 1 to 50	75.00
3	Drill set, letter, A to Z	75.00
3	Tap and die sets, N.C. and N.F. series, No. 4 screw to 1" bolt	100.00
3	Die sets, N.C. and N.F. Series, No. 4 screw to 1" bolt	300.00
	Clamps, "C" and parallel, assorted	85.00
	Center drills, countersinks, spot facer, assorted sizes	50.00
1	Tap wrenches, T handle, set	25.00
-	Reamers, assorted sizes	200.00
1	Pipe tapes and dies, set, $\frac{1}{8}$ " to 2"	125.00
	Small specialty tools and gages and measuring instruments	400.00
6	Angle plates 2-4x4, 2-6x6, 2-10x10	360.00
1	Micrometer depth gage, range 0" to 6", 5" base	35.00
2	Micrometer calipers, inside, range 2" to 12"	60.00

APPENDIX C. SUGGESTED LIST OF EQUIPMENT

<u>Quantity</u>	<u>Description</u>	<u>Estimated total cost</u>
1	Indexing head	\$240.00
3	Tilting, indexing, and rotary tables	420.00
8	Drill press vises	120.00
2	Milling machine vises, graduated swivel	338.00
8	Bench vises, swivel base, 4" jaws	440.00
2	Work benches	146.00
	Lathe tools and attachments (boring bars, knurling tools, dogs, drill chucks, sleeves), assorted	500.00
1	Tapping attachment for high production tapping on drill press with chuck and lead screw	550.00
2	Bench plates, precision ground, 14" x 18"	224.00
2 sets	Mechanical drawing equipment, complete including: T-square, instruments, 31 x 42 board, triangles curves, drawing pencils, erasing shield, etc.	90.00
20	Personnel lockers, steel, double compartments 31" h x 24" d x 18" w	500.00
3	Laboratory work tables, 30" x 5' top	114.00
2	Drawing tables, adjustable, 30" x 36" top	300.00
20	Tablet armchairs	18.00
2	Drafting stools	150.00
1	Instructor's chair and desk	75.00
1	File cabinet, 4-drawer	75.00
1	Projector, filmstrip or slide	185.00
1	Overhead projector	500.00
1	Projector, 16 mm, sound	300.00
	Allowance for slides and transparencies	

APPENDIX D. SUGGESTED LIST OF EXPENDABLE SUPPLIES

<u>Quantity</u>	<u>Description</u>	<u>Estimated total cost</u>
100 lbs.	Rags	\$ 10.00
60	Power hacksaw blades, 18 teeth by .932" by 14" long HSS	35.00
60	Hand hacksaw blades, 24 teeth by .025" by 10"	10.25
60	Hand hacksaw blades, 32 teeth by .025" by 10"	10.25
15 gal.	Machine oil	30.00
30 gal.	"Bestol" thread cutting oil	90.00
2 boxes	Rex AAA tool bits, 1/4"	40.00
2 boxes	Rex AAA tool bits, 5/16"	45.00
2 boxes	Rex AAA tool bits, 7/16"	55.00
2 boxes	Rex AAA tool bits, 3/8"	50.00
2 boxes	Rex AAA tool bits, 1/2"	75.00
500 sheets	Fine emery cloth	50.00
1 doz.	12" mill files	15.00
1 doz.	10" bastard files	13.00
100'	Cold rolled steel, 1/4" round	4.77
100'	Cold rolled steel, 3/8" round	11.30
100'	Cold rolled steel, 1/2" round	20.64
100'	Cold rolled steel, 5/8" round	31.30
100'	Cold rolled steel, 3/4" round	45.06
100'	Cold rolled steel, 1" round	70.10
100'	Cold rolled steel, 1 1/8", round	95.00
100'	Cold rolled steel, 1 1/4", round	102.50
100'	Cold rolled steel, 1 3/8", round	135.00
100'	Cold rolled steel, 1 1/2", round	146.00
100'	Cold rolled steel, 2", round	254.50
100'	Cold rolled steel, 1/2", square	29.85
100'	Cold rolled steel, 5/8", square	46.50
100'	Cold rolled steel, 3/4", square	64.90
100'	Cold rolled steel, 1", square	115.65

<u>Quantity</u>	<u>Description</u>	<u>Estimated total cost</u>
100'	Cold rolled steel, 1/2" hex	\$ 35.00
100'	Cold rolled steel, 5/8" hex	52.50
100'	Cold rolled steel, 3/4" hex	68 90
72'	Stainless steel, 1" diameter, type 303, machining quality	288.00
120'	Brass rod, 1" diameter, free cutting	367.20
36'	Brass rod, 2" diameter, free cutting	421.20
72'	Aluminum rod, 2" diameter, 2011-T3	324.00
72'	Aluminum rod, 1 1/2" square, 2024-T4	194.40
60 lbs.	Carbon vanadium tool steel, 1.0% carbon	60.00
20'	High speed tool, steel 1/2" bar stock	35.00
60'	Drill rod, carbon steel	780.00
500 lbs.	Grey iron castings	500.00
1	Refill kit first aid supplies	15.00

APPENDIX E

SUGGESTED TRAINING FACILITY

